Ch.1 Inertial Frames and classical Mechanics

SR : The comparison of measurements made in Different inertial reference Frames (IRF's)

Newtons 2nd Law holds in IRF

$\sum \bar{F} = m\bar{a}$ ← For constant mass

Yields

$$\sum \bar{F}_x = m\vec{a}_x$$
$$\sum \bar{F}_y = m\vec{a}_y$$
$$\sum \bar{F}_z = m\vec{a}_z$$

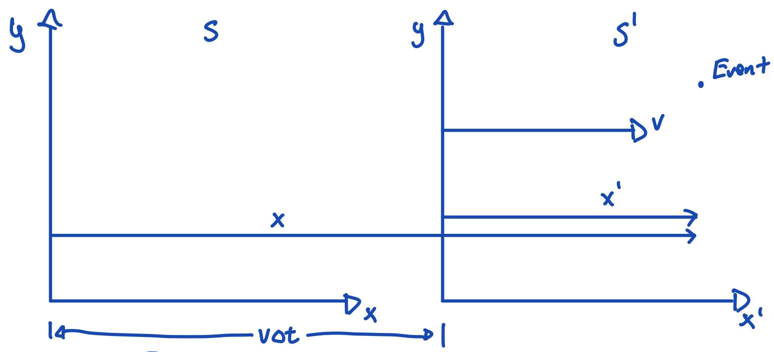
IN an IRF w/o net Force....

$$\sum \vec{F} = 0 = m\vec{a} \therefore a_x = a_y = a_z = 0$$

$$\therefore \bar{v} = \text{Constant}$$

Galilean Transformation

Event : Need 4 coordinates i.e (t, x, y, z)



Note: Time is considered absolute Same For all observers

$$\left[\begin{aligned} x' &= x + vt \\ y' &= y \\ z' &= z \\ t' &= t \end{aligned}\right]$$

← Galilean transformation

S Labels it as (t, x, y, z)

S' Labels it as (t', x', y', z')

All wrong

$$t_2' = t_1' \ , \ t_2 = t_1$$

Notice :

From the GT's length differences and time intervals the same in both Frames.

Lets let $x_1 : x_2$ be the coordinates of the left and right ends of a meterstick

- The length OF the Stick, according to S, is $x_2 - x_1 = \ell$
- The length OF the Stick, according to S', is $x_2' - x_1' = \ell'$

$t_2 = t_1$

$$\begin{aligned} \ell' &= x_2' - x_1' \\ &= x_2 - Vt_2 - (x_1 - Vt_1) \\ &= x_2 - x_1 - v\underbrace{(t_2 - t_1)}_{=0} \\ &= x_2 - x_1 = \ell \end{aligned}$$

Taking the time derivatives of the G.T's . . .

$$V_x' = \frac{dx'}{dt'} = \frac{d}{dt}(x - vt) = \frac{dx}{dt} - V = V_x - V$$

$$V_y' = \frac{dy'}{dt'} = \frac{d}{dt}y = V_y$$

$$V_z' = \frac{dz'}{dt'} = \frac{d}{dt}z = V_z$$

Galilean Velocity Transformations

$$\begin{bmatrix} V_x' = V_x - V \\ V_y' = V_y \\ V_z' = V_z \end{bmatrix}$$ - Galilean Velocity Transformation

Are Newtons Laws of mechanics in all inertial reference frames?

Taking $\frac{d}{dt}$ of G.V.T

$$a_x' = \frac{dv_x'}{dt'} = \frac{d}{dt}(v_x - v) = \frac{dv_x}{dt} - (V_x - V) = \frac{dv_x}{dt} = a_x$$

$$a_y' = \frac{dv_y'}{dt'} = \frac{d}{dt}v_y = a_y$$

$$a_z' = a_z$$

$$\therefore \quad \vec{a}' = \vec{a}$$

$$\sum \vec{F}' = \sum \vec{F}$$

Newtons 2^{nd} law is invariant under GT

$\Rightarrow$ All IRF see the same laws of nature